



Rural Electrification

by ROBERT T. BEALL¹

THE MOST advanced country in the world in the use of modern methods in industry and agriculture, the United States has lagged astonishingly in making electricity available to farm communities. In 1935 about 10 percent of our farm families were receiving central-station electrical service as compared with almost 95 percent in France, 90 percent in Japan, 85 percent in Denmark, 100 percent in Holland. Since 1935 vigorous action has stepped up the number in this country to 25 percent. Here is the interesting story of the developments that have resulted in a more rapid advance in rural electrification than this country has ever seen. The author also tells how farmers can get electric service, and he lists over 200 uses of electricity on the farm and discusses the comparative costs of operating various kinds of electrical equipment.

PRIOR to 1935 an extremely small percentage of farms in the United States were receiving central-station electrical service. Industries and residents in urban areas, having recognized the value of reliable, low-cost power, had almost universally adopted electricity. Farmers, however, had not enjoyed electric power to any great extent—largely because it had not been made available on terms they could afford.

Of the more than 6.3 million farms in the country in January 1925, only 204,780, or 3.2 percent, were receiving central-station electrical service. During the succeeding 6 years the percentage increased slowly, reaching 10.2 in January 1931. From 1931 to January 1935 the increase was negligible, the percentage on the latter date being 10.9, or a gain of about 0.7 percent in 4 years. In terms of number of farms receiving central-station service during the 10-year period 1925-34 the record is but slightly more impressive; the number

¹ Robert T. Beall is Economist, Rural Electrification Administration.

increased from 204,780 in January 1925 to 649,919 in 1931, and to 743,954 in January 1935.

In contrast to the 10.9 percent of the farms in the United States receiving central-station service in 1935, other countries had achieved much more rapid progress in making electricity available to agriculture. For instance, in Ontario in 1935 about 20 percent of the farms were electrified, in New Zealand over 60 percent, in Japan and Germany about 90 percent each, in France between 90 and 95 percent, in Sweden about 65 percent, in Norway over 55 percent, in Denmark over 85 percent, and in the Netherlands practically 100 percent. Though conditions differ among these foreign countries in such factors as density of population, type of farming, per capita income, and form of government, it is significant that they have developed ways and means to make electricity available to such a large percentage of their farms. In most of these other countries, rural electrification has been characterized by wide availability, a high percentage of public or cooperative ownership, and long-term programs under government sponsorship. It is unlikely that rural electrification would be so extensive in these countries except under such auspices.

THE LAG IN RURAL ELECTRIFICATION IN THE UNITED STATES

In view of the growing but relatively ineffective demand of American farmers for electricity on their farms during the decade prior to 1935 and the contrasting substantial progress in rural electrification achieved by many foreign countries during the same period, it is important to note briefly the reasons why relatively few farms in the United States were being served with central-station power. After a careful study of the rural electrification problem, the Mississippi Valley Committee reported, in October 1934, that—

several reasons might be advanced to explain why only 10 percent of the Nation's farms purchase electricity. These are the lack of interest by operating companies in rural electrification, high cost of line construction because of the unnecessarily expensive type of line used, onerous restrictions covering rural line extensions, and high rates.²

Inasmuch as the private utility companies own and control well over 90 percent of the electric-power industry in the United States, the extension of lines into rural areas prior to 1935 depended primarily on the willingness of these companies to serve farmers. However, it was the assumption generally of the great majority of these companies that the average farmer was unable to use sufficient quantities of electric power to justify the costs of rendering service; that electricity could be brought to only a few farms except when lines had to be built for some other purpose; and that justifiable extensions were dependent on factors other than the use of electric power in household and ordinary farm activities.

Of particular importance in creating the apathetic attitude of the private industry toward rural electrification was the fact that the companies did not want to invest large blocks of capital in thinly

² UNITED STATES FEDERAL EMERGENCY ADMINISTRATION OF PUBLIC WORKS, MISSISSIPPI VALLEY COMMITTEE. REPORT OF THE MISSISSIPPI VALLEY COMMITTEE . . . 234 pp., illus. Washington, D. C. 1934. See p. 51.

populated rural territory when they were experiencing a satisfying increase in business from the more profitable and easily accessible markets in urban areas of denser population. This attitude was in accord with the dominant policies of conserving invested capital and selecting markets that promise the greatest profit. Rural areas did not offer the conservative investment opportunities of urban communities where the uses for electricity were rapidly expanding—particularly for street lighting, commercial and industrial power, household appliances, and more recently display advertising—and it was normal from a strictly business point of view for private industry to select for development these more conservative yet more profitable opportunities for investment. From a business point of view the companies did not need the rural market.

The most important barriers restricting rural electrification prior to 1935—and these reflected generally the attitude of private industry—were the conditions and rates imposed on farmers if service were made available to them. Frequently the farmers had to pay for the distribution line, give the company title to the property, and then guarantee high minimum charges over a long period of years. Charges for rural service, often based on the costly urban type of construction and usually on high, nonpromotional rate schedules, made electrification prohibitive to all but a favorably situated class of farm people. The industry generally felt no responsibility to find out whether construction in rural areas might not be simpler and less expensive than that in urban centers and therefore require less capital investment per farm. It made little effort to work out promotional rate schedules that would enable and encourage farmers to employ electric power in their activities.

As already indicated, rural electrification prior to 1935 was on the whole restricted to a selected class of farm residents. Generally these farmers were located along the main highways extending out from urban centers, where density of population was relatively high, or in sections of the country where the nature of farm activities made large power loads immediately available. In the irrigated sections of the West, as in California, rural electrification was extensive because the pumping of water for irrigation required large amounts of power; in areas of specialized farm activities, such as dairying and poultry farming, farms required relatively large blocks of power and offered readily available and profitable loads to the utility industry. In most rural areas devoted to general farming, however, line extensions were usually short, frequently not more than a mile or two each, and usually to only a few customers in the more prosperous and densely settled communities. In very few localities were any attempts made to develop entire areas, including sections of thin as well as of dense population, in order that electric power might be available to substantially all the farms in an area. Rather, electrification was conducted on a highly selective, an almost individual-farm basis, a condition which meant that each farm or small group of farms was evaluated on its potential profitability as an isolated unit. The effect of this type of line-extension policy was not only to restrict in a large degree the number of farms served but also to make construction costs unduly high because of piecemeal additions.

RURAL ELECTRIFICATION AND RURAL PROGRESS

That only 1 farm in 10 in the United States was receiving central-station service in 1935 did not mean that farmers generally did not want or could not use electric service. On the contrary, extension of electricity to rural areas on conditions that promote its maximum use in farm operations stands out as a vital need for the all-round improvement of rural life. Not only does the wide use of electricity hold much promise in raising the standard of living of individual farmers and their families, but also it offers real opportunities to make a substantial contribution to community welfare and national well-being through its applications in promoting a more permanent and stable agriculture.

Electric power is a factor common to many parts of the broad program to restore farm life to its proper plane in the national economy, and it reinforces many of the activities being carried on to achieve that objective. The electrified farm, for instance, generally attracts and holds better tenants, and it may prove to be a constructive force in promoting an increase in owner-operated farms as well as better landlord-tenant relationships. Increased income and improved living standards resulting from the use of electricity on the farm may exert a favorable influence on the problems arising from the migration of rural youth to urban centers and the distribution of population. Many of the productive applications of electricity on the farm will reinforce and make more effective the programs of soil conservation and farm rehabilitation by facilitating wider diversification of crops and adjustment of farm operations to proper land use. In a very real sense the electrification of rural areas is of national concern, not only because of its contributions to the comforts and income of the individual farm family but also because of its influence on the welfare of agriculture generally.

Recognizing the need for rural electrification, farmers, farm organizations, and public-spirited leaders have for many years exerted much effort to make electric service widely available in rural areas. They have approached the problem from many angles, realizing that the inadequacy of this service to farmers is one of the distinguishing features of the gap between rural and urban living standards. Notwithstanding the slow progress of rural electrification before 1935, the desire of farmers for electricity increased rapidly. Every time a farmer visited a market center he observed the uses and convenience of electric power; educational and promotional literature confirmed these impressions.

In addition to the growing demand of farmers for electric service, a small but energetic group of public-spirited citizens has for many years been advocating widespread rural electrification. These citizens, among the earliest of whom were Senator George W. Norris and Gifford Pinchot, and somewhat later Franklin D. Roosevelt and Morris L. Cooke, may at the beginning have conceived of electric power on the farm as a desirable thing, but as their thinking expanded they recognized it as a necessity in modern life and a matter of national concern.

The October 1934 report of the Mississippi Valley Committee, of

which Morris L. Cooke was chairman, after a careful review of the causes of the lag in rural electrification in the United States, emphasized the opportunities for extending electric power to farmers but added:

Unless the Federal Government assumes an active leadership, assisted in particular instances by State and local agencies, only a negligible part of this task can be accomplished within any reasonable time.³

A similar point of view was expressed in the report of the National Resources Board of December 1934.⁴

These documents focused attention on the fact that something concrete should be done to bring electricity to the farmer. At the rate of progress of rural electrification during the decade 1924-33 it would take about 50 years to make electric service available to 50 percent of the farms in the United States.

PROGRESS IN RURAL ELECTRIFICATION

In his message to the Congress in January 1935, the President recommended the adoption of legislation which would reduce the rolls of the unemployed and cited the program of the National Resources Board as a guide for useful public expenditures. In the Emergency Relief Appropriation Act of 1935, Congress expressly included rural electrification as one of the classes of projects for which the appropriation was made available. Under this act, the President, by Executive Order No. 7037, on May 11, 1935, established the Rural Electrification Administration as an emergency agency "to initiate, formulate, administer, and supervise a program of approved projects with respect to the generation, transmission, and distribution of electric energy in rural areas." Relief funds were made available to be loaned to private companies, power districts, municipalities, and cooperatives. A year later Congress passed the Rural Electrification Act of 1936, which transformed the Rural Electrification Administration from an emergency to a more permanent agency of the Federal Government, established a 10-year program of rural electrification, and authorized for this purpose loans eventually totaling \$410,000,000. Of this total, the Administration was authorized to borrow \$50,000,000 from the Reconstruction Finance Corporation for loans during the fiscal year 1937, and \$40,000,000 was authorized for each of the succeeding 9 years, the appropriation for each of these years being subject to a specific act of the Congress. In 1938 Congress authorized the Reconstruction Finance Corporation to lend \$100,000,000 to the Rural Electrification Administration for the purpose of making rural-electrification loans, this amount being in addition to the regular loan appropriation of \$40,000,000 for the year beginning July 1, 1938. In June 1940 Congress authorized the Reconstruction Finance Corporation to lend \$100,000,000 to the Administration for similar loans during the year beginning July 1, 1940. The Administration was placed under the general direction and supervision of the Secretary of Agriculture on July 1, 1939.

³ See reference cited in footnote 2, p. 791.

⁴ [UNITED STATES] NATIONAL RESOURCES BOARD. A REPORT ON NATIONAL PLANNING AND PUBLIC WORKS IN RELATION TO NATURAL RESOURCES AND INCLUDING LAND USE AND WATER RESOURCES WITH FINDINGS AND RECOMMENDATIONS. 455 pp., illus. 1934. See p. 353.

Briefly, the Rural Electrification Act of 1936 provides that loans, which shall be self-liquidating within a period not to exceed 25 years, may be made to persons, corporations, States, Territories, municipalities, people's utility districts, and cooperative, nonprofit, or limited-dividend associations organized under the laws of any State or Territory of the United States, for the purpose of financing the construction and operation of generating plants, transmission lines, and distribution lines for the furnishing of electric energy to persons in rural areas who are not receiving central-station service. These loans are made on terms and conditions determined by the Rural Electrification Administrator and may be made payable in whole or in part out of income. The act also provides that loans may be made for wiring premises and the acquisition and installation of electrical and plumbing appliances and equipment. Such loans may be made to borrowers of funds loaned for line construction or to businesses supplying and installing wiring, appliances, or equipment. All loans bear interest, the rate for any year being the average rate of interest paid by the Federal Government on its obligations not maturing for 10 or more years and issued in the preceding year. The act specifies that no loan shall be made unless the Administrator finds and certifies that in his judgment the security therefor is reasonably adequate and that the loan will be repaid within the time agreed. In accordance with the terms of the act, the interest rate on Rural Electrification Administration loans made in each fiscal year has been as follows: 2.77 percent in 1937, 2.88 in 1938, 2.73 in 1939, and 2.69 in 1940.

Because it was created as an agency not only to extend rural electrification but also to stimulate business and relieve unemployment, the Administration had to make an initial assumption as to how it would function. The Rural Electrification Administration was established as a purely lending agency; it could not itself construct, own, or operate electric-distribution systems. As a lending agency having as one of its objectives to lend rapidly in order to put funds into circulation promptly, it was assumed that under the reasonable conditions established and low interest rates offered the private utility companies would constitute the principal borrowers of the funds inasmuch as they were going concerns, had generating plants, experience, and facilities for prompt action, and had signified their intentions to promote actively the development of rural areas. These conditions, including area coverage, economical construction, and simplified and lower rate schedules, were designed to remove or modify the barriers that had impeded progress in rural electrification before 1935. But of the \$268,037,293 allotted by the Administration up to December 31, 1939, less than 2 percent has been borrowed by private companies for rural extensions.

Within a year after the Administration was established a new type of borrower came into being—the nonprofit local distributing organization, or cooperative; and soon these new associations of farmers became the principal borrowers of Government funds for the construction and operation of rural electric-distribution systems. This development began at a slow pace at first but accelerated as more farm communities discovered how they could organize to get electricity by forming cooperative, nonprofit enterprises

under their State laws to borrow funds from the Administration.

The Rural Electrification Act in fact provides that in making loans preference should be given to these associations as well as to States, Territories, municipalities, and people's utility districts. Of the total amount lent by December 31, 1939, over 92 percent had been borrowed by cooperative associations and about 6 percent by public power districts and other public bodies.

The Work of the Rural Electrification Administration

From the beginning the Rural Electrification Administration recognized that if the objectives of the rural-electrification program were to be achieved, a new approach would have to be made on many fronts in order to remove or modify substantially the barriers that had impeded progress in the past. This meant that comprehensive area coverage was needed, cost of line construction would have to be reduced, and more favorable rates and rate schedules must be made possible. Achievement of these objectives, it was recognized, would enable farmers to obtain maximum benefit from the full use of electric power in their activities. These objectives and the emergence of cooperative associations, a type of organization relatively new to the electric-utility industry in the United States, as the principal borrowers have involved pioneering work of many types.

One of the basic principles the Administration has encouraged its borrowers to follow is that of comprehensive area coverage. This simply means trying to reach all farms in an entire area by designing compact systems which do not leave gaps of unserved sectors within the area or some farms stranded on the fringes. The practice generally followed prior to 1935, of building only to those farms promising relatively large loads and ignoring all other potential consumers, often referred to as "skimming the cream," deprives the large number of remaining farms of the probability of ever receiving electric service, because lines can be extended to them in the future only at exorbitant cost. On the other hand, comprehensive area coverage as practiced by Rural Electrification Administration borrowers assures availability of service to most of the farms within a compact area, because mass-production methods of line construction can be utilized and the resulting lower costs averaged over both large and small consumers. The application of the principle of area coverage has eliminated one of the greatest barriers to widespread farm electrification.

By placing line construction on a mass-production basis and simplifying and standardizing designs and materials, the Administration engineers have been able to achieve substantial reductions in the costs of rural lines, the effect of which has been to broaden the area of economical widespread rural electrification. Every reduction in the cost of line construction is reflected in farmers' electric bills, from which must come the funds for amortization of the Government loans; lower line costs mean an increase in the number of farmers who can be supplied with electric power on a self-liquidating basis.

Before the establishment of the Rural Electrification Administration the reported cost of rural lines, depending on consumer density and on terrain, ranged from \$1,500 to \$1,800 a mile. The average total cost of R.E.A.-financed lines is now less than \$800 a mile.

The average estimated construction cost of these lines has been declining each year, from \$904 in 1936 to \$858 in 1937, \$768 in 1938, and \$583 in 1939. These economies have not been achieved by inferior design and construction; R.E.A. standards of line design are now followed generally throughout the country by private companies as well as by borrowers of Government funds.

A substantial part of these reductions has been achieved by designing rural lines to fit the particular requirements of farm service. With few exceptions, rural-line construction in the past had followed the urban practice of heavy construction. The Administration recognized that urban-type lines were not required in farm areas; that light, simple line construction would be more economical and would

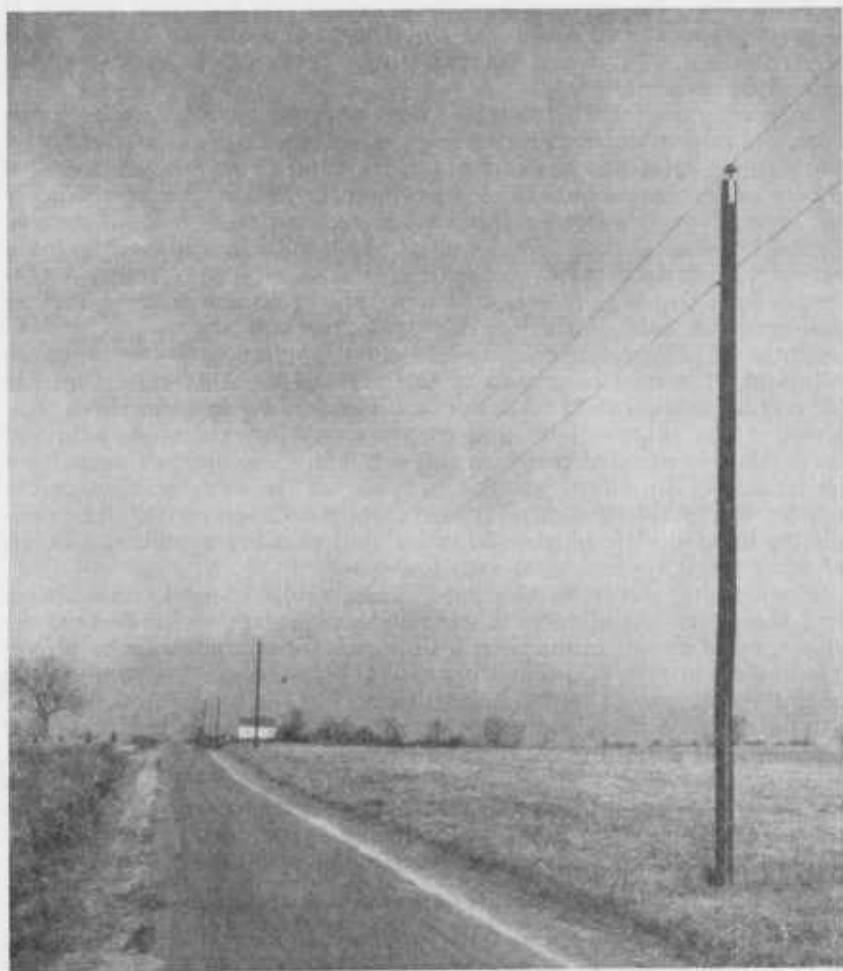


Figure 1.—Simple, long-span construction of single-phase distribution lines means lower costs and makes electricity available to more farms.

serve the needs of the farmer (fig. 1). This necessitated the application of new techniques to rural construction. Some of these had been known previously and had been used here and there by certain private companies; but because of the general lack of interest and particularly the absence of rural extension programs, they had not received any wide acceptance. A simple design for rural lines suitable for rural conditions was found in the now common vertical construction with the elimination of the cross arm. Another important technique in rural-line design that has resulted in substantial reduction in line costs has been the increased length of the span between poles with a consequent reduction in the number of poles per mile. In contrast to usual spans of 200 to 225 feet in 1935, the average span of R.E.A.-financed lines is now 400 to 425 feet.

While the new type of line-design standards for rural service is the best-known contribution of the R.E.A. to more economical rural electrification, there are several other technical advances which should be mentioned.

In cooperation with manufacturers a cyclometer-type meter has been developed which permits easy, direct reading and reporting by the farmer. Reading the common clock-type meter requires a skilled reader and costs about 15 cents a month. With the new type of meter read by the farmer this cost is reduced to 3 cents a month.

The latest important development has been a new low-cost, small-capacity electric service—consisting of a small transformer, a new device for lightning protection, a new type of circuit breaker, and an underground cable—which will enable farmers with very limited incomes to have electric lights and small appliances for a minimum of about \$1 a month instead of the average monthly minimum bill for regular service of \$2.50 in the South and \$3.50 to \$4 in the North. Even at the substantially and progressively lowered costs achieved since the Government program started, many low-income farms have been unable to afford electric service. This new, small-capacity service will enable the small tenant farmer or sharecropper, for example, to have electric lights and radio, and possibly a limited number of other small appliances at very low cost.

Engineering advances relating primarily to technical construction and the operation of rural lines include a new meter for testing the efficiency of circuit grounding; a slide rule for computation of proper guy and anchor sizes; and another slide rule for accurate determination of proper equipment to regulate voltage.

The effect of these and other engineering advances in design and technique of rural-line construction has been not only to lower substantially the cost of rural lines, which in turn means lower rates for electric power, but also to make possible the extension of electric service to many farm areas where it had heretofore been considered uneconomical on the basis of urban standards of construction.

The Rural Electric Cooperative Associations

As has already been indicated, the principal type of borrower of R.E.A. funds is the cooperative, nonprofit association of rural residents organized for the specific purpose of constructing and operating a rural electric system. Although this type of organization

for the distribution of electric power in rural areas has been widely used in certain foreign countries, notably Denmark, Sweden, and Finland, it was almost unknown in the United States until the establishment of the Government's rural-electrification program. In 1934 there were 34 such associations in existence in the United States. One of these had been organized in 1914, and the majority of them had been in operation 10 years or more. Most of these pioneer associations have been handicapped by unplanned and inadequately financed lines and lack of expert counsel, but it is significant that they have been in operation for many years.

The development of a cooperative association for the purpose of borrowing funds from the R.E.A. is a local matter and reflects the desires of the residents of a rural community for electric service. Usually a small group of farmers begins a cooperative by writing the Administration that they wish electric service in their community. Farmers usually find the county agent and local planning committees to be of great assistance to them in getting their organizations started, by calling mass meetings, sending out notifications, and acting as advisers. The Administration does not make loans to individual farmers because the cost of rendering electric service on an individual basis would be exorbitant; economical and efficient service must be obtained through collective action. It recommends that the cooperative association consist of farmers in a compact rural area with at least 100 miles of line and approximately 300 members, or a density of about 3 to the mile. After the residents of an area signify their desire for electric service, the Administration recommends procedures and helps them in many ways to perfect their community association in order that they may apply for a Government loan to finance the construction of their lines. The preliminary steps to the formation of a cooperative are usually taken at a community meeting called by the county agent or other farm leaders in the community. After selection of the tentative area where it is expected the lines will be built, the group selects the persons, usually not less than nine, to become the incorporators of the proposed cooperative. The cooperatives are incorporated under laws of the respective States, this being handled by local attorneys selected by the sponsors.

After the incorporation of the cooperative, the next step of the local group is to make a membership survey, obtain easements, collect membership fees, and prepare a map for the proposed lines, all of which is preliminary to and necessary for submission of a suitable loan application to the Rural Electrification Administration. In order that this work may be done properly, the Administration informs local people of the best procedures to follow. The cooperatives are democratic community organizations; every consumer receiving service from them is a member and pays a membership fee, which is usually \$5. Each member is entitled to receive all the benefits provided by the cooperative and to have a vote in its management.

When a loan application is received, the Administration examines it for economic and engineering feasibility. The loans generally cover the total cost of constructing the electric-distribution lines, which constitute the entire security for the loan, so that members of the

cooperatives are not personally liable for repayment. The rate schedule established by the cooperative makes provision for an income that will permit payment of principal and interest on the Government loan as well as costs of wholesale power and operating expenses.

A loan for the construction of a generating plant is not made unless it is found to be absolutely essential to the successful operation of a borrower's distribution system. Existing generating sources are used wherever practicable. In some cases, however, a loan has been made for a generating plant because of the absence of a satisfactory power source or because the borrower could not afford to purchase power at the wholesale rate demanded by an existing plant (fig. 2). A total of \$6,529,000 had been allotted by December 31, 1939, for the construction of generating plants in 20 States.

In the organization, construction, and operation of their rural distribution systems, cooperatives may receive considerable guidance from the Administration. These expert and technical advisory services are to help cooperatives to become economical and efficient business enterprises capable of managing their systems successfully. R.E.A. experts aid borrowers in obtaining a satisfactory source of power and reasonable wholesale rates, essentials to successful operation of their systems. R.E.A. engineers counsel borrowers' engineers in the design and plan of the lines, review and approve

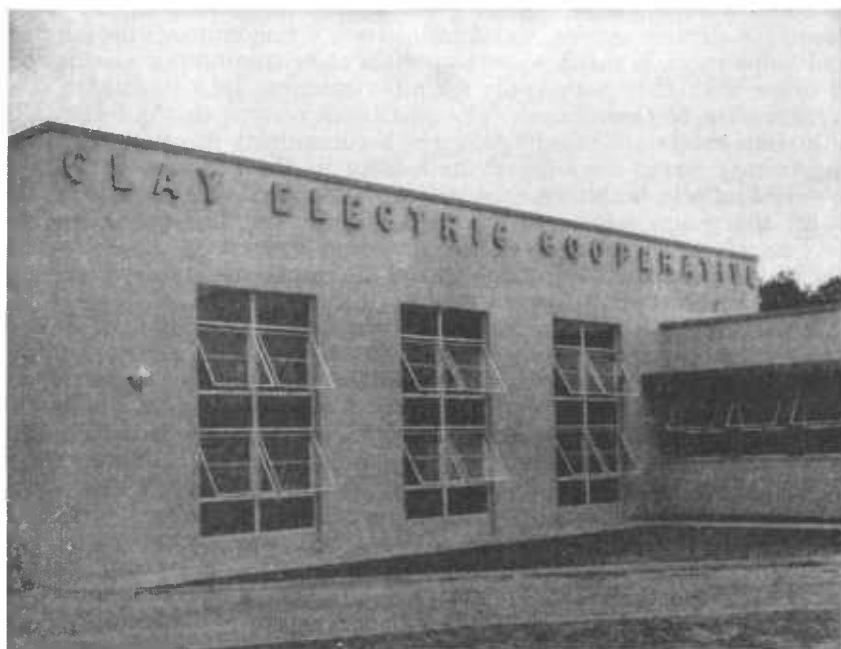


Figure 2.—Such a generating plant as this may be built by a cooperative with money borrowed from the Rural Electrification Administration when electric power from existing sources is not available or cannot be obtained under satisfactory conditions.

construction contracts, and assist in the supervision of line construction.

After construction is completed and the lines are energized, borrowers receive expert advice from the Administration in connection with the development of good management practices and the promotion of use of electricity on the farm. These activities are of an advisory nature and do not involve participation in the actual operation of the electric systems. The Administration also has trained specialists who work with borrowers in demonstrating the many uses of electricity on the farm and arranging exhibits of electrical equipment. Most of these load-building activities are conducted in cooperation with specialists from the extension divisions of State universities, county agents, and other representatives of the Department of Agriculture. Group plans for obtaining low-cost installations of plumbing and wiring have been developed in order to make these conveniences available to as many farms as possible. In all of these and other activities the primary objective has been to make electricity available to farmers at lowest costs and to safeguard the security of the Government loans.

In addition to loans for distribution lines and generating plants, the Administration makes loans for the acquisition and installation of wiring and plumbing. These loans are not made directly to individual farmers but to the cooperative or other group of borrowers, which in turn makes loans to individuals for these purposes. Wiring and plumbing loans bear interest and are made on a 5-year basis. By December 31, 1939, the R.E.A. had made wiring and plumbing loans totaling \$5,001,862. Borrowers may also take advantage of the facilities of the Electric Home and Farm Authority, an agency of the Federal Government which lends funds for the purchase of all types of electrical equipment.

Accomplishments and Problems

Farm electrification in the United States has received a new stimulus from the Government's program of financing and aiding farmers to obtain electric power. Since the establishment of the program in 1935 the electrification of rural areas has gone forward at a faster pace than ever before. In the 4½ years since the Rural Electrification Administration was established, the number of farms receiving electric service has more than doubled; it is estimated that in December 1939 about 1,700,000 farms, or 25 percent of all farms, were receiving electric service. Table 1 shows the number and percentage of farms receiving central-station service for each year from 1925 to 1939, inclusive. This substantial increase in the number of electrified farms reflects the activities both of private utility companies that have been stimulated by the Rural Electrification Administration and of borrowers of its funds. Lines under construction at the end of 1939 by R.E.A. borrowers alone will make power available to almost 300,000 additional farms within the next year.

By December 31, 1939, the Administration had made allotments of loan funds totaling \$268,037,293 to 690 borrowers for the construction of about 250,000 miles of rural power lines and other power facilities. When completed, these lines will make central-station service available to almost 850,000 farms, rural churches, schools, and business enter-

Table 1.—Progress of rural electrification in the United States, 1924–39

Year ended Jan. 1—	Electrified farms	Proportion of all farms electrified	Year ended Jan. 1—	Electrified farms	Proportion of all farms electrified	Year ended Jan. 1—	Electrified farms	Proportion of all farms electrified
	<i>Number</i>	<i>Percent</i>		<i>Number</i>	<i>Percent</i>		<i>Number</i>	<i>Percent</i>
1925.....	204,780	3.2	1931.....	649,919	10.2	1937.....	1,042,924	15.4
1926.....	246,150	3.9	1932.....	698,786	10.7	1938.....	1,241,505	18.2
1927.....	309,125	4.9	1933.....	709,449	10.5	1939.....	1,410,000	20.6
1928.....	393,221	6.2	1934.....	713,558	10.5	1940.....	1,700,000	25.0
1929.....	506,242	8.0	1935.....	743,954	10.9			
1930.....	576,168	9.2	1936.....	788,795	11.6			

Source: Number of electrified farms: 1925–30, Statistical Bulletin No. 2, April 1935, Edison Electric Institute; 1931–33, Electrical World, January 1938; 1939–40, R. E. A. estimates.

prises. It is reported that on December 31, 1939, there were about 435,000 consumers receiving service from Government-financed lines.

The distribution of R. E. A. allotments, number of borrowers, and percentage of total farms electrified, by States, are shown in table 2. In connection with the allotments among the States it should be pointed out that the Rural Electrification Act provides that 50 percent of the annual funds available for loans shall be allotted in the several States in the proportion which the number of their farms not then receiving central-station service bears to the total number of farms

Table 2.—Rural Electrification Administration allotments, number of borrowers, and percentage of all farms electrified, by States ¹

State	Allotments	Borrowers	Proportion of farms electrified, June 30, 1939	State	Allotments	Borrowers	Proportion of farms electrified, June 30, 1939
	<i>Dollars</i>	<i>Number</i>	<i>Percent</i>		<i>Dollars</i>	<i>Number</i>	<i>Percent</i>
Alabama.....	5,468,550	15	10	Nevada.....	227,000	1	35
Arizona.....	703,000	3	46	New Hampshire.....	392,000	1	52
Arkansas.....	5,608,500	14	3	New Jersey.....	420,300	2	78
California.....	1,748,500	4	75	New Mexico.....	710,000	3	7
Colorado.....	3,402,500	11	17	New York.....	1,375,000	1	45
Connecticut.....			45	North Carolina.....	6,219,350	22	19
Delaware.....	878,000	1	31	North Dakota.....	1,988,972	7	2
Florida.....	1,763,000	8	10	Ohio.....	14,344,025	26	42
Georgia.....	13,864,615	36	14	Oklahoma.....	6,529,000	18	5
Idaho.....	2,545,750	7	54	Oregon.....	1,002,500	6	50
Illinois.....	14,952,130	27	27	Pennsylvania.....	7,222,200	13	52
Indiana.....	17,120,195	43	37	Rhode Island.....			84
Iowa.....	17,800,628	50	23	South Carolina.....	4,073,328	12	14
Kansas.....	5,761,151	20	11	South Dakota.....	1,738,500	5	5
Kentucky.....	8,658,700	24	8	Tennessee.....	8,695,058	17	10
Louisiana.....	3,064,600	12	7	Texas.....	20,306,685	59	9
Maine.....	225,000	2	44	Utah.....	579,000	3	54
Maryland.....	748,000	2	33	Vermont.....	280,500	2	34
Massachusetts.....			48	Virginia.....	6,356,800	15	21
Michigan.....	11,252,500	14	62	Washington.....	3,644,200	13	57
Minnesota.....	18,127,236	39	17	West Virginia.....	582,000	2	15
Mississippi.....	7,911,200	23	4	Wisconsin.....	13,398,800	28	36
Missouri.....	11,568,700	30	8	Wyoming.....	1,719,800	10	14
Montana.....	2,393,100	11	15				
Nebraska.....	10,670,700	28	13	United States.....	268,037,293	690	22

¹ Data on allotments and number of borrowers as of Dec. 31, 1939.

of the United States not then receiving such service; the remaining 50 percent shall be allotted at the discretion of the Administrator, provided that not more than 10 percent of the remainder of the annual sum may be allotted in any one State or in all of the Territories.

The program, in addition to providing funds for financing rural electrification, has exerted considerable influence on private companies by stimulating a renewed interest on their part in extending lines into rural areas. By designing lines particularly for rural areas, the Administration has demonstrated that construction and operating costs can be reduced substantially below previous levels and that adequate electric service can be rendered over wide areas at rates and under conditions more in accord with the purchasing power of farm consumers.

The general adoption of R.E.A. standards of line design by private companies has contributed to the extension of their lines into areas formerly considered to be uneconomical. In many areas, however, the proposed development of cooperatives has provided the major stimulus to the accelerated rural activities of the private companies.⁶ Many private companies have modified their terms and have offered lower and promotional rate schedules. Many have eliminated or substantially modified their requirements of contributions by farmers to cost of line construction and are building lines without requiring immediate investment by the farmers. In some places the principle of area coverage has been accepted by progressive companies, but selective building, or cream skimming, practices are still common.

As a result of the Federal rural-electrification program and the increased rural activities of private companies, public interest in rural electrification has increased and many farmers have become acquainted with the uses and desirability of electric power on the farm. Manufacturers of electrical appliances and equipment have come to recognize the importance of electrified farms as an outlet for their products and are actively engaged in developing this market. Through periodicals, demonstrations, and exhibits and through the activities of the Extension Service, farm organizations, State colleges, and other public agencies, farmers are being informed of the applications of electric power to farm-household and farm-production activities.

Notwithstanding the current progress being made in extending electric service to rural areas, the major problem of rural electrification remains primarily one of wider availability, making electrification available to as many farms as possible on conditions and terms that will encourage its maximum use in agricultural activities. The magnitude of this task is apparent when it is realized that about 3 out of 4 farms in the United States are still without electric service. In

⁶ In its report of October 3, 1936, the Wisconsin Rural Electrification Coordination stated that "startled out of a long sleep by farmers' R. E. A. cooperative activity, private electric companies in the State jumped to their feet with sudden, new plans to extend rural lines to farmers whose requests had gone begging some twenty years." (Wisconsin Rural Electrification Coordination, *The First Year of R. E. A. Program in Wisconsin*, October 3, 1936, p. 3.) The Kansas State Corporation Commission reported that "in addition to their electric supply lines constructed, the activity of the cooperatives has served to intensify the effort on the part of the private power companies to develop the territory immediately adjacent to urban and rural territories now served by the companies." (Kansas State Corporation Commission, *Fourteenth Biennial Report*, July 1, 1936, to June 30, 1938, pp. 17-18.) The Public Service Commission of Kentucky reported that "faced with competition, many private utility companies, formerly reluctant to run rural line extensions in any but the most profitable areas, have reduced minimum monthly bills, and waived former contribution requirements to encourage new rural business." (Kentucky Public Service Commission Report, 1936 and 1937, pp. 27-28.)

many States, as shown in table 2, less than 10 percent of the farms are receiving central-station service. The extension of electric service to the large number of unserved farms will require the coordinated efforts of the farmers, their organizations, the suppliers of electric power, and the research, planning, educational, and administrative agencies of every level of Government in developing and perfecting programs for its achievement.

RURAL USES OF ELECTRICITY

Electric power on the farm is beneficial—in fact, is feasible economically—to the extent only that it is used profitably and effectively in household and productive activities. In itself electricity is only a “tool” to be used. Urban industry has found it to be the most flexible and versatile of all sources of power; agriculture may find it of equal or greater importance in the performance of farm activities. Already there are over 200 separate uses for electric power on the farm, and the list continues to grow. While many of these uses relate primarily to household activities, a substantial number of them are directly concerned with labor-saving, cost-reducing, and income-producing equipment for farm operations. Since the farm provides both a home and a livelihood, many uses of electricity in the household have a direct influence on productivity by relieving the farmer and



Figure 3.—Electricity lessens the drudgery of washday and performs many other chores in the farm household.

his family of much time-consuming drudgery and by adding to their comforts. The use of electric power in rural areas may be divided into three broad classes: (1) Household operations (fig. 3), (2) farm operations, and (3) rural community services.

Electricity in the Farm Home

The initial desire of farm people, particularly farm women, for electric service often arises from its use for electric lights and for performing common household tasks and chores. Electric service in the farm home means a better standard of living, greater freedom from drudgery, improved health, and greater contentment for the entire farm family. While electric lights are universally used on electrified farms, many other appliances are widely used because of their contribution to better living. It is a natural tendency for consumers of electricity to acquire first the more common and better-known electrical appliances and gradually to add to others as knowledge and information about them is acquired and as circumstances permit. An appliance survey conducted by the R.E.A. during the summer of 1939 among more than 72,000 consumers on the lines of 121 of its borrowers indicates the popularity of the more common household appliances among farmers who have been receiving electricity for a short time—an average of slightly over 10 months. The results of this survey are shown in the following tabulation:

Appliance	Percentage of farms reporting use	Appliance	Percentage of farms reporting use
Iron.....	84. 1	Hot plate.....	19. 1
Radio.....	82. 6	Electric water pump.....	18. 4
Washing machine.....	58. 7	Coffee maker.....	6. 3
Refrigerator.....	32. 2	Range.....	3. 1
Toaster.....	30. 8	Roaster.....	1. 6
Vacuum cleaner.....	21. 3		

In addition to the appliances listed above it is of interest to note that 9 percent of these consumers reported bathtubs or showers, 6.3 percent both septic tanks and water closets, and 1.2 percent electric water heaters. The percentages shown are significant not only because they indicate the popularity of various household appliances among farmers who have had electricity available for a short period but also because of the high saturation obtained in this relatively short period.

Many household appliances consume very little electric power, and their costs of operation are surprisingly low, especially when consideration is given to the amount of time saved and drudgery eliminated through their use. As the result of tests made by various State colleges, utility companies, and manufacturers, it is conservatively estimated that the average family of four or five persons uses the average amount of electricity shown to operate the following household appliances:

Kilowatt-hours of electricity used per month

Appliance:		Appliance—Continued.	
Clock.....	2	Curling iron.....	½
Coffee percolator.....	5	House heating (oil burner) ..	25

Kilowatt-hours of electricity used per month—Continued

Appliance—Continued.		Appliance—Continued.	
Household motor.....	1	Toaster.....	3
Iron (hand).....	5	Vacuum cleaner.....	2
Ironing machine.....	10	Waffle iron.....	2
Lighting.....	20	Washing machine.....	3
Radio.....	8	Water heater.....	240
Range.....	140	Water pump (shallow well)...	8
Dishwasher.....	2½	Water pump (deep well)....	10
Fan (household).....	2	<i>Kilowatts per hour of use</i>	
Fan (kitchen).....	8	Heater (glowing or radiant)...	1
Refrigerator.....	45	Heating pad.....	½
Sewing machine.....	½		

By multiplying these consumption figures by the rate for electric energy, approximate costs of operation for each appliance may be obtained. At 4 cents per kilowatt-hour (1,000 watts for 1 hour), for instance, it would cost 8 cents a month to operate an electric clock, 32 cents a month for the radio, 12 cents for the toaster, and 30 to 40 cents for the water pump. In making such computations, it is important to remember that the more power used, the lower the rate.

Electricity in Farm Operations

Though the uses of electricity for productive farm operations are less well known than are home uses, electric power offers substantial opportunities to farmers for more effective and profitable performance of many of their farm operations.

Many farmers have discovered new sources of income because of the availability of electric power; others have found that they can reduce their operating costs below those of methods previously used; still others have been able to save time which they have used to profitable advantage in other activities. It has been stated that there is not a stationary operation on the farm today, indoors or out, in the doing of which electricity cannot be used. On the other hand, electric power has not been applied in the United States, except largely on an experimental basis, to mobile farm operations such as plowing and hauling. It is of interest to note that some electrical plowing is being done in certain European countries.

The survey of electrical equipment mentioned previously indicates the most popular items of farm electrical equipment purchased by farmers who have been receiving electric service for an average period of about 10 months. A list of these items of equipment, with the percentage of their use by the reporting farmers, is as follows:

<i>Equipment</i>	<i>Percentage of farms reporting use</i>	<i>Equipment</i>	<i>Percentage of farms reporting use</i>
Motor, up to 1 horsepower	18. 0	Milk cooler (fig. 4).....	0. 7
Cream separator.....	14. 0	Poultry water warmer.....	. 5
Poultry-house lighting.....	10. 0	Feed grinder.....	. 5
Milking machine.....	3. 8	Dairy water heater.....	. 3
Brooder.....	3. 2	Hotbed heating.....	. 1
Electric fence.....	2. 7	Stock-tank heater.....	. 1
Motor, 1 horsepower and over..	2. 3		

Not every farm has need for all of these pieces of equipment; one farm may need a brooder, another a cream separator. Many farmers



Figure 4.—The electric milk cooler eliminates losses from spoiled or rejected milk and increases profits by making possible milk of high quality.

have developed plans for gradually electrifying their operations as conditions warrant.

Many of the most effective and profitable applications of electricity to farm operations require very small amounts of electric power per unit of productive activity. A list of some of these operations with the average unit power requirements of each is given in the following tabulation:

<i>Appliance</i>	<i>Kilowatt-hours</i>
Apple-butter stirrer.....	$\frac{1}{4}$ per gallon.
Apple-cider mill.....	$\frac{3}{4}$ per 100 gallons.
Barn ventilator (during season).....	50 per month.
Bone and shell grinder.....	2 per ton.
Bottle washer.....	$\frac{1}{2}$ per 1,000 bottles.
Brooder.....	$\frac{1}{2}$ per chick raised.
Bull exerciser.....	$\frac{1}{4}$ per hour of use.
Churn.....	$1\frac{1}{2}$ per 100 pounds of butter.
Clipper (for horse or cow).....	$\frac{1}{4}$ per hour of use.
Concrete mixer.....	$\frac{1}{2}$ per cubic yard of concrete.
Corn husker-shredder.....	30 per 100 bushels of corn husked.
Corn sheller.....	$\frac{1}{4}$ per 100 pounds of shelled corn.
Cream separator.....	$\frac{1}{4}$ per cow per month.
Dairy refrigerator (during season).....	30 per 10 gallons of milk daily per month.

<i>Appliance</i>	<i>Kilowatt-hours</i>
Dairy water heater.....	7 per cow per month.
Fence.....	4 per month.
Fly screen (during season).....	5 per month.
Grain elevator.....	4 per 1,000 bushels.
Grain grinder.....	1 per 100 pounds.
Grain, seed cleaner and grader.....	1 per 100 pounds.
Green-feed cutter and root shredder.....	2 per ton.
Hay baler.....	2½ per ton.
Hay drier.....	40 per ton of dry hay.
Hay hoist.....	½ per ton.
Hotbed.....	1 per square yard per day.
Incubator.....	¼ per chick hatched.
Irrigation (surface).....	3 to raise an acre-foot of water 1 foot.
Milking machine (portable).....	1½ per cow per month.
Milking machine (pipe line).....	3 per cow per month.
Oat sprouter.....	75 per 1,000 chickens per month.
Paint sprayer.....	½ per 250 square feet.
Poultry-house lighting (during season).....	5 per 100 birds per month.
Poultry water heater.....	1 per day.
Sheep shearer.....	2 to shear 100 sheep.
Silage cutter.....	1 per ton.
Straw cutter.....	2 per ton.
Threshing machine.....	½ per 100 pounds of grain.
Tool grinder.....	¼ per hour of use.
Ultraviolet lights for poultry.....	10 per 100 hens per month.
Utility motor (small ¼ horsepower).....	½ per hour of use.
Utility motor (3 and 5 horsepower).....	1 per horsepower per hour of use.
Water pump for all farm uses.....	25 per month.
Wood saw.....	2 per cord of wood.

The figures presented make possible an approximation of the cost of electric power for these operations. In estimating the cost of performing various farm operations by assuming a rate per kilowatt-hour, it should be borne in mind that promotional rate schedules provide for lower rates and therefore lower costs as consumption of power increases.

Electricity in Rural Community, Institutions

In addition to serving the individual farms of a community, rural electric service is making a real contribution to community activities and undertakings in a great variety of appliances. Community institutions such as churches, schoolhouses, community centers, and lodge halls are found to be of greater service and benefit to farm people when electricity is made available. Entertainment, movies, and educational meetings can be held at night under attractive conditions. Lights, ventilation, and controlled heat enable rural schools to equal urban schools to the benefit of farm children. Rural community enterprises such as stores, garages, and gas stations have many uses for electricity that enable them to render better service to their farm customers. All of these and many other uses of electricity contribute to a better rural community life, a higher standard of living for rural people, and generally more unified and stable agricultural communities.

The availability of electric power throughout rural areas is making possible a desirable combination of agriculture and industry. Already there are definite signs of a beginning of decentralization of certain types of industry from the large industrial centers where their requirements for power have forced them to locate. The increasing accept-

ance of cooperative enterprises in rural areas may well provide the foundation for small industries to utilize the products of the farm for processing into commodities, which in turn will find their market in the local community as well as in the cities. Some of these processing enterprises offer possibilities for whole or part-time employment of those who work and live on the farms in the community. For instance, a woodworking plant operated by electric power may be established to utilize the products of the farm woodlands. Other possibilities include the processing of dairy, fruit, and vegetable products and electrically operated cotton gins, grain elevators, and mills. In many sections of the country cooperative refrigerators and cold-storage plants are rendering a desirable farm service for promoting health, increasing income, and fostering improved farming practices. For these and other types of community enterprises rural electric service offers a flexible source of heat, light, and power.